Forces and Motion

8-5 The student will demonstrate an understanding of the effects of forces on the motion of an object. (Physical Science)

8-5.3 Analyze the effects of forces (including gravity and friction) on the speed and direction of an object.
Taxonomy level: 4.1-B Analyze Conceptual Knowledge

Previous/Future knowledge: Students have been introduced to the concept the pull of gravity in 3rd grade (3-5.4) and to the concepts of the effects of forces of gravity and friction on the motion of objects in 5th grade (5-5.1). Students have not been analyzed the effects of forces of gravity and friction with regards to the speed and direction of an object in previous grade levels. Students will further develop the concepts of the effects of gravity quantitatively in high school Physical Science (PS-5.5)

It is essential for students to know that forces (including gravity and friction) can affect the speed and direction of an object.

Gravity

- *Gravity* is a force that always attracts or pulls objects toward each other without direct contact or impact.
- Gravitational attraction depends on the mass of the two objects and the distance they are apart.
- Objects on Earth are pulled toward the center of Earth.
- The force of gravity, like all other forces, can cause changes in the speed of objects. As an object falls, its speed will continually increase as Earth's gravity continually pulls it downward. When air resistance is ignored, all objects will speed up at the same rate as they fall.
- Gravity can also cause an object that is thrown into the air to change its upward motion, slow down, and fall back toward Earth's surface.
- The pull of Earth's gravity keeps the Moon in orbit; the moon is constantly changing direction because of gravity.

Friction

- *Friction* is a force that occurs when one object rubs against another object. Two factors determine the amount of friction – (1) the kinds of surfaces, and (2) the force pressing the surfaces together.
- Friction is the force that acts to resist sliding between two surfaces that are touching. It can slow down or stop the motion of an object.
    - The slowing force of friction always acts in the direction opposite to the force causing the motion.
    - For example, friction slows or stops the motion of moving parts of machines.
    - Another example would be athletic shoes with tread grooves to increase friction have better traction for starting or stopping motion than smooth-soled dress shoes.
- Friction can also be the force that makes it difficult to start an object moving. Enough force must be applied to a nonmoving object to overcome the friction between the touching surfaces.

- The smoother the two surfaces are, the less friction there is between them; therefore, the moving object will not slow down as quickly.
  - Friction between surfaces can be reduced, in order for objects to move more easily, by smoothing the surfaces, using wheels or rollers between the surfaces, or lubricating/oiling the surfaces.
  - If friction could be removed, an object would continue to move.
- The greater the force pushing the two surfaces together, the stronger friction prevents the surfaces from moving.
  - As an object gets heavier, the force of friction between the surfaces becomes greater.
  - To move a heavy object, a greater force must be applied to overcome the friction between the surfaces.

It is not essential for students to know how to calculate acceleration due to gravity, calculate weight, or the effect of gravity on different masses. Students do not need to differentiate between static, sliding, or rolling friction.

Assessment Guidelines:
The objective of this indicator is to *analyze* the effects of gravity and friction on the speed and direction of objects; therefore, the primary focus of assessment should be to determine how the forces of gravity and friction relate to the overall concept of speed and direction of objects. However, appropriate assessments should also require students to explain the effects of gravity or friction on the speed and direction of objects; *infer* whether gravity or friction could be causing a given change in the speed or direction of an object; or *exemplify* effects of gravity or friction on the speed and direction of an object.